

## Claims

1. An apparatus for determining the concentration of scale-forming ions; the apparatus comprising;
  - 5 a ligand which binds scaling ions in a sample of fluid, said ligand having an electronic configuration which is altered on binding of a scaling ion, said ligand being placed in the vicinity of a flow of said fluid;
  - 10 a detector for determining alterations in said electronic configuration, the amount of said alterations being indicative of the concentration of the scaling ion in the sample.
- 15 2. An apparatus according to claim 1 wherein the scaling ion is selected from the group consisting of  $\text{Ca}^{2+}$ ,  $\text{Ba}^{2+}$  and  $\text{Sr}^{2+}$  ions.
3. An apparatus according to claim 1 or claim 2 wherein
  - 20 the detector comprises one or more electrodes for determining changes in the electroactivity of said ligand..
4. An apparatus according to claim 3 wherein the ligand
  - 25 is immobilised on conducting particles attached to one or more of said electrodes.
5. An apparatus according to claim 4 such that wherein said conducting particles are carbon or metal particles.
- 30 6. An apparatus according to claim 5 wherein the metal particles are gold particles.

7. An apparatus according to any one of claims 4 to 6 wherein said particles with immobilised ligands thereon form a conducting porous electrode.
- 5 8. An apparatus according to claim 1 wherein a ligand comprises oxygen and/or nitrogen.
9. An apparatus according to any one of the preceding claims wherein the ligand is a BAPTA derivative.
- 10 10. An apparatus according to any one of the preceding claims wherein the ligand is a cryptand derivative.
11. An apparatus according to any one of the preceding claims comprising a processor for calculating the concentration of the scaling ion in the sample water from alterations in the electronic configuration of the ligand.
- 15 12. An apparatus according to claim 11 comprising a ligand binding two or more different scaling ions and generating a different electronic configuration in response thereto.
- 20 13. An apparatus according to claim 11 comprising two or more different ligands, said detector being adapted to determine alterations in the electronic configuration of each ligand independently.
- 25 14. An apparatus according to claim 13 wherein each of the said two or more ligands binds to a different combination of scaling ions.
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15. An apparatus according to any one of the preceding claims comprising a porous membrane which allows ions from fluid to contact the ligand.
- 5 16. An apparatus according to claim 15 wherein the membrane is ceramic or zeolite.
17. An apparatus according to any one of the preceding claims comprising ligands embedded in a block of porous material, said block being exposed to a fluid flow.
- 10 18. An apparatus according to any one of the preceding claims wherein the fluid is a wellbore effluent.
- 15 19. An apparatus according to any one of the preceding claims wherein the fluid stems from a production flow from a wellbore.
- 20 20. An apparatus according to any one of the preceding claims being adapted to be placed in a subterranean location.
- 25 21. A method of monitoring the concentrations of scaling ions comprising;
- contacting a fluid flow with a ligand which selectively binds scaling ions, wherein the binding of scaling ions in said sample to the ligand alters the electronic configuration of the ligand;
- 30 measuring changes in the electronic configuration of the ligand; and,
- determining the concentration of said scaling ion from said change in the electronic configuration.

22. A method according to claim 21 wherein the scaling ions are selected from the group consisting of  $\text{Ca}^{2+}$ ,  $\text{Ba}^{2+}$  and  $\text{Sr}^{2+}$  ions.

5 23. A method according to claim 21 or claim 22 wherein the change in electronic configuration is determined by measuring alterations in the electroactivity of the ligand.

10 24. A method according to any one of claims 21 to 23 wherein the ligand is a BAPTA derivative.

25. A method according to any one of claims 21 to 23 wherein the ligand is a cryptand derivative.

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25. A method according to any one of the preceding claims wherein the ligand binds two or more different scaling ions and generates a different electronic configuration in response thereto.

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26. A method according to any one of the preceding claims comprising contacting the sample with two or more different ligands and determining alterations in the electronic configuration of each ligand.

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27. A method according to claim 26 wherein each of the said two or more ligands binds to a different combination of scaling ions.

30 28. A method according to any one of the preceding claims including the step of monitoring the production of a wellbore.

29. A method according to any one of the preceding claims including the step of predicting the scaling of hydrocarbon production tubulars or equipment.

- 5 30. A method according to any one of the preceding claims including the step of monitoring the scaling of hydrocarbon production tubulars or equipment in a downhole location.

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